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ABSTRACT

A course, called Nature of Science, is described as developed over the eight years it has been presented to nonscience majors at a liberal arts college. The aims of the course are to show important ties between science and those disciplines in which nonscience students' primary interests lie; to develop in nonscience students the recognition that an intelligent perspective on science will be an essential part of their thinking; and to introduce them to works about science which can serve as prototypes for a continuing nonprofessional interest in science. The structure of the course is in two parts, each running for one ten-week term. Details of class meetings, scheduling, prerequisites, and participant characteristics are presented. The content, about 40% science and 60% about science, is based on course materials listed in an attached bibliography. Criteria for book selection and a sequence of presentation of course content is outlined. The first major topic is the Copernican Revolution, the second the Darwinian-Mendelian Revolution, and the third behaviorism. Procedures for examinations and grading are presented, and the promotion of a worldview by the teacher is discussed. Ratings from students evaluation forms indicate uniform commendation. (Author/KSM)

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AN INTERDISCIPLINARY COURSE ON THE SIGNIFICANCE OF SCIENCE

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Science courses for nonscience undergraduates cover a broad range, from preprofessional courses in a particular science to survey courses in physical or biological science to histories or philosophies of science to interdisciplinary courses in such areas as environmental problems and science-government relations. This diversity does not, I think, mean that we are groping awkwardly for the solution to what a science course for nonscientists should be. Rather, it is a recognition that the problem itself is pluralistic. Different institutions vary widely in the numbers of nonscience students in diverse areas from art to literature to religion, and in their backgrounds. To meet varying needs, a variety of courses is only appropriate.

I will describe here a course, called Nature of Science, which we have developed over the past eight years to meet some of the needs of the nonscience students at our liberal arts college. The aims of the course are: to show important ties between science and those disciplines in which nonscience students' primary interests lie; to develop in nonscience students the recognition that an intelligent perspective on science will be an essential part of their thinking, and to start them toward such a perspective; and to introduce them to works about science which can serve as prototypes for a continuing nonprofessional interest in science.

Structure The Nature-of-Science course consists of two parts; each part runs for one ten-week term, four fifty-minute

class meetings per week, for a total of eighty class meetings in the course. There is no laboratory. Students may take one or both parts of the course in either order. (Their alternative to meet our de facto science requirement is an introductory course in biology, chemistry-physics, or environmental science.) Students at any undergraduate level may take the course; there are no prerequisites.

About 600 students have taken one or both parts of the course since 1965. About 35% have been seniors, 35% juniors, 20% sophomores, and 10% freshmen. About 50% have been students majoring in the social and behavioral sciences, 30% in the humanities, 15% in the creative arts, and 5% in the sciences. Except for this last group, the vast majority have had no science beyond high school.

Maximum enrollment per section is thirty students. The classroom format is Socratic discussion of assigned readings, an approach which is usually familiar and congenial to nonscience students. For each ten-week part of the course, the student's grade consists of 25% for his discussion work and 25% for each of three written exams (the exam format is discussed below). All grades are on a 100-point scale, converted by pre-established formula to course letter grades; there is no curve grading.

Content Polykarp Kusch has pointed out the value of distinguishing between teaching science and teaching about science.

By this standard, the Nature-of-Science course is about 40% science and 60% about science. The substance of the course (but not its aims) has evolved a good deal over the years, and it would exceed the scope of this article to discuss successive mutations and the selective forces which operated on them. As a concise summary, I've listed under Bibliography texts which have been used in the course at one time or another. Bibliographic entries marked with an asterisk (*) are those currently used in the course. I believe any of the books listed would be worth considering for a course directed at a student audience of the type described, and I have, in my own course, discarded certain books in favor of others only because the replacements provided better logistical fit in the course or made certain emphases which seemed important for my students.

In selecting a book for inclusion in the course, I use the following questions as criteria; the weight of each criterion depends on the book under consideration, but, in general, those questions listed earlier carry more weight.

(1) Does the book show the significance of science for our educated world-view? (This point is further discussed in the section below headed World-View.)

(2) Is it pitched at the right level for nonscience undergraduates?

(3) Is the book authoritative?

(4) If the book deals with unsettled questions, does it, by itself or in conjunction with other books in the course, present a balanced view?

(5) Does the book fit well logistically with other books in the course? (Is it about the right length? Is it congruent but not redundant to other books in the course?)

(6) Is the book well written? Is it attractive enough to the nonscience student to serve as a prototype for readings he might pursue himself?

At present, I replace about 20% of the books in the course each year. I would, of course, welcome recommendations from readers about books for possible inclusion in the course.

In its present embodiment, the course begins with a brief (1 class meeting of 80) consideration of an essay by Gerald Holton [12] which stresses the importance of science as part of an intelligent world-view. The remainder of the course is divided into the study, in historical order, of three major scientific developments and their influence on the world-view of our Western culture.

The first major topic is the Copernican Revolution. Kuhn's book [16] (14 class meetings) provides the basic scientific and cultural information; de Santillana's book [9] (9 class meetings)

studies Galileo's problems with the Church as a microcosm of the cultural religious-scientific dilemma of the 17th century; and Russell's book [21] (7 class meetings) presents a brief survey of religious-scientific controversy.

The second major topic is the Darwinian-Mendelian Revolution. Wald's article on "The Origin of Life" [26] (1 class meeting) is a charmingly lucid introduction; Hardin's book [11] (8 class meetings) presents the basic scientific and cultural information; and Julian Huxley's book [14] (2 class meetings) extends the evolutionary-genetic view into a comprehensive cultural philosophy, with application to the population problem.

The third major topic is behaviorism. The argument for behaviorism as a world-view is given by Skinner [22] (9 class meetings); an opposing and scientifically informed view is given by Aldous Huxley [13] (3 class meetings) in the context of a discussion of the significance of psychoactive drugs. An extension of Huxley's argument into a comprehensive view of nature in its scientific and mystical aspects is presented by Watts [28] (6 class meetings).

The six exams are an important part of the course. Three class meetings are reserved for each exam: one for review, one for the exam itself, and one for discussion of the exam. Graded exams with individual written comments on each student's answers are returned in the class meeting following the one in

which the exam is given. I've found that the pressure thus incurred in grading is more than repaid by the results of quick feedback to and from the students.

Exams are frequently a good index to a course. Over the years, I've worked out an exam format for this course which seems to work excellently. Each (fifty-minute) exam consists of five parts, with two questions in each part; the student is instructed to answer one question in each part. Thus, each student answers a controlled selection of five questions from ten; each question is constructed to warrant an essay answer taking about ten minutes.

The balance of control and selection built into the exam format both guarantees a certain coverage of the material studied and allows the student to spend more exam time on aspects of particular interest to him. The questions range from the simply factual ("What is gene fixation, under what circumstances is it likely to occur, and is it good or bad?") to matters of defensible opinion ("State whether or not you agree with Skinner's definition of 'self' as 'a repertoire of behavior' and support your agreement or disagreement."). The format allows each student to bias his exam toward the position on the fact-opinion spectrum he prefers, but not to avoid some questions of each type.

Grading is standard throughout: each exam receives 25 points to start and a possible 15 points for each answer, for a

possible total of 100 points (many questions are explicitly or implicitly three-part questions to facilitate answering and grading). The pre-established scale for all grades in the course (discussion grade, exam grades, and the course grade itself) is 100-93 A, 92-84 B, 83-70 C, 69-60 D, 59-0 F.

World-View Every course promotes a world-view, a Weltanschauung. This function is especially prominent in an interdisciplinary science course for nonscientists, where the aim is to suggest the legitimate place of science in the informed outlook of men and women whose professional commitments lie elsewhere.

If a course is to meet this responsibility without sacrificing education to propaganda, it must present a world-view which is as explicit, supported, and balanced as the nature of the material and the prejudices of the teacher permit. Operationally, this means choosing texts which are equal advocates of opposing views (as, for example, [21] and [28], [13] and [22]) and designing the course so as to transform a stack of books into an organic survey. In this respect, the chronological approach is helpful, both because it is usually familiar to nonscience students and because it allows them to acknowledge the profound world-view impact which scientific developments have had in the past before asking them to consider whether they are faced with analogous needs to readjust their own views.

The teacher also incurs certain responsibilities. He must try to make his own world-view clear, but not intrusive, and he must be prepared to support it by reasoned argument, since in education a belief which one can not or will not defend is dogma. Operationally, this responsibility is conveniently met by a Socratic approach in which the student defends whichever side of an argument he chooses and the teacher defends the opposite view; grades depend on quality of argument and not conclusions.

Most of all, the teacher must exhibit the paradigm of that characteristic he is chiefly concerned to elicit in his students: readiness to change his mind when a superior argument warrants.

Evaluation The Nature-of-Science course has had high and steady enrollment pressure and very high ratings on AAUP student-evaluation forms. Reactions of colleagues have been uniformly commendatory. Interests elicited by the course have led to spinoff seminars and ad hoc courses on science and government, science and religion, science and literature, and the philosophy of behaviorism.

Unexpectedly, the course has been found to attract some science students, who feel that it puts their preprofessional work in a larger perspective.

Summary I have described here an undergraduate course

on the significance of science for nonscientists. The course has been well received and seems to have a legitimate place alongside other science-for-nonscientist offerings.

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